Claims

1. A data processing method in a channel equalizer of a receiver, the method comprising:

estimating interference from a received signal at a first observation time, creating a first covariance matrix on the basis of the estimation and defining an inverse matrix of the first covariance matrix and a Cholesky decomposition matrix;

removing selected covariance components from the Cholesky decomposition matrix;

computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix;

estimating interference from a received signal at a second observation time and determining additional covariance components on the basis of the estimation;

creating the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations; and

generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix.

2. The method of claim 1, further comprising means for filtering additional covariance components.

3. The method of claim 1, further defining the Cholesky decomposition of the inverse matrix of the first covariance matrix of the form $\mathbf{W}_p = \begin{pmatrix} \omega_p & \bar{\mathbf{0}}^H \\ \boldsymbol{\omega}_p & \boldsymbol{\Omega}_p \end{pmatrix}$,

where ω_p is a scalar, $\boldsymbol{\omega}_p$ is a vector, $\bar{\mathbf{o}}^H$ is a zero vector and $\boldsymbol{\Omega}_p$ is a lower triangular sub-matrix.

4. The method of claim 1, further comprising the step of partitioning the inverse matrix of the first covariance matrix as $\mathbf{U}(n)=\begin{pmatrix} u_p & \mathbf{u}_p^H \\ \mathbf{u}_p & \mathbf{U}_p \end{pmatrix}$,

wherein u_p is a scalar, $\mathbf{u}_p$ is a vector, $\mathbf{u}_p{}^H$ is a complex-conjugate transpose vector, $\mathbf{U}_p$ is a sub-matrix and H is a complex-conjugate transpose matrix.

5. The method of claim 1, wherein the selection of the covariance components to be removed is based on the size of the sliding step of a signal window.

6. The method of claim 1, further comprising the steps of determining additional covariance components as

$$\begin{pmatrix} \boldsymbol{\sigma}_f \\ \sigma_f \end{pmatrix} = \left(H(n)\left[diag\left(1-\hat{b}^2(n)\right)\right]H^H(n)+I\delta_0^2\right)\begin{pmatrix} \mathbf{0} \\ 1 \end{pmatrix},$$

wherein $\boldsymbol{\sigma}_f$ is covariance component vector, σ_f is a covariance component located in the corner of the second covariance matrix, H(n) is a system matrix in the observation time of the second covariance matrix, diag is a diagonal matrix, $\hat{b}(n)$ is a symbol estimate, H is a complex conjugate matrix, σ_0^2 is the noise variance, and I is an interference matrix.

7. The method of claim 1, further comprising the step of defining the computation of the inverse of the sub-matrix $\bar{\Sigma}$ representing the common part of the two consecutive covariance matrices with the aid of determination $\bar{\Sigma}^{-1}=\overline{\boldsymbol{\Omega}}\overline{\boldsymbol{\Omega}}^H$, wherein $\overline{\boldsymbol{\Omega}}$ is a sub-matrix and $\overline{\boldsymbol{\Omega}}^H$ is a complex-conjugate transpose of the sub-matrix.

8. The method of claim 1, further comprising the step of defining Cholesky factorisation of the inverse matrix of the second covariance matrix as

$$\mathbf{W}_f = \begin{pmatrix} \overline{\mathbf{\Omega}} & -\sqrt{u_f}\,\overline{\mathbf{\Omega}}\overline{\mathbf{\Omega}}^H \sigma_f \\ \overline{\mathbf{o}}^H & \sqrt{u_f} \end{pmatrix}\Theta,$$

wherein $\overline{\mathbf{\Omega}}$ is a sub-matrix, $\overline{\mathbf{o}}^H$ is a zero vector, $\overline{\mathbf{\Omega}}^H$ is a complex-conjugate transpose of the sub-matrix, $u_f = \left(\sigma_f - \boldsymbol{\sigma}_f^H \overline{\Omega\Omega}^H \boldsymbol{\sigma}_f\right)$, σ_f is a covariance component, Θ is a series of unitary rotations and H is a complex-conjugate transpose matrix.

9. The method of claim 1, wherein an output signal of an equalizer is generated as follows:

$$z_k(n) = \beta_k(n)\left(\alpha_k(n)\hat{b}_k(n) + \eta_k^H(n)\mathbf{W}_f^H \tilde{\mathbf{r}}(n)\right)$$

wherein $\alpha_k(n) = \eta_k^H(n)\eta_k(n)$, $\eta_k(n) = \mathbf{W}_f^H \mathbf{h}_k(n)$, $\beta_k(n) = 1 - \dfrac{\alpha_k(n)}{\alpha_k(n) + \left|\hat{b}_k(n)\right|^{-2}}$,

$\mathbf{h}_k(n)$ is a channel response vector, n is an nth symbol, H is a complex-conjugate transpose matrix, $\hat{b}_k(n)$ is a symbol estimate based on a channel decoder feedback, $\mathbf{W}_f = \begin{pmatrix} \overline{\mathbf{\Omega}} & -\sqrt{u_f}\,\overline{\mathbf{\Omega}}\overline{\mathbf{\Omega}}^H \sigma_f \\ \overline{\mathbf{o}}^H & \sqrt{u_f} \end{pmatrix}\Theta$ wherein $\overline{\mathbf{\Omega}}$ is a sub-matrix, $\overline{\mathbf{o}}^H$ is a zero vector, $\overline{\mathbf{\Omega}}^H$ is a complex-conjugate transpose of the sub-matrix, $u_f = \left(\sigma_f - \boldsymbol{\sigma}_f^H \overline{\Omega\Omega}^H \boldsymbol{\sigma}_f\right)$, σ_f is a covariance component, Θ is a series of unitary rotations and H is a complex-conjugate transpose matrix, $\tilde{\mathbf{r}}(n) = \mathbf{r}(n) - \mathbf{H}\hat{\mathbf{b}}$ where $\mathbf{H}_k(n)$ is a channel response matrix and n means an nth symbol.

10. The method of claim 1, wherein the output value of the channel equalizer is generated by further utilizing a-priori symbol estimate information.

11. An equalizer comprising:

means for estimating interference from a received signal at a first observation time, creating a first covariance matrix on the basis of the estimation and defining an inverse matrix of the first covariance matrix and a Cholesky decomposition matrix;

means for removing selected covariance components from the Cholesky decomposition matrix;

means for computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix;

means for estimating interference from a received signal at a second observation time and determining additional covariance components on the basis of the estimation;

means for creating the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations; and

means for generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix.

12. The equalizer of claim 11, wherein the Cholesky decomposition of the inverse matrix of the first covariance matrix is of the form $\mathbf{W}_p = \begin{pmatrix} \omega_p & \bar{\mathbf{o}}^H \\ \boldsymbol{\omega}_p & \boldsymbol{\Omega}_p \end{pmatrix}$,

where ω_p is a scalar, $\boldsymbol{\omega}_p$ is a vector, $\bar{\mathbf{o}}^H$ is a zero vector and $\boldsymbol{\Omega}_p$ is a lower triangular sub-matrix.

13. The equalizer of claim 11, wherein the inverse matrix of the first covariance matrix is partitioned as $\mathrm{U}(n) = \begin{pmatrix} u_p & \mathbf{u}_p^H \\ \mathbf{u}_p & \mathbf{U}_p \end{pmatrix}$,

wherein u_p is a scalar, $\mathbf{u}_p$ is a vector, $\mathbf{u}_p^H$ is a complex-conjugate transpose vector, $\mathbf{U}_p$ is a sub-matrix and H is a complex-conjugate transpose matrix.

14. The equalizer of claim 11, wherein the selection of the covariance components to be removed is based on the size of the sliding step of the signal window.

15. The equalizer of claim 11, wherein additional covariance components are determined as $\begin{pmatrix} \boldsymbol{\sigma}_f \\ \sigma_f \end{pmatrix} = \left(H(n)\left[diag\left(1 - \hat{b}^2(n)\right)\right]H^H(n) + I\delta_0^2\right)\begin{pmatrix} \mathbf{0} \\ 1 \end{pmatrix}$,

wherein $\boldsymbol{\sigma}_f$ is covariance component vector, σ_f is a covariance component located in the corner of the second covariance matrix, H(n) is a system matrix in the observation time of the second covariance matrix, diag is a diagonal matrix, $\hat{b}(n)$ is a symbol estimate, H is a complex conjugate matrix, σ_0^2 is the noise variance, and I is an interference matrix.

16. The equalizer of claim 11, wherein the computation of the inverse of the sub-matrix $\overline{\Sigma}$ representing the common part of the two consecutive covariance matrices is defined with the aid of determination $\overline{\Sigma}^{-1} = \overline{\mathbf{\Omega}}\overline{\mathbf{\Omega}}^H$, wherein $\overline{\mathbf{\Omega}}$ is a sub-matrix and $\overline{\mathbf{\Omega}}^H$ is a complex-conjugate transpose of the sub-matrix.

17. The equalizer of claim 11, wherein Cholesky factorisation of the inverse matrix of the second covariance matrix is defined as $\mathbf{W}_f = \begin{pmatrix} \overline{\mathbf{\Omega}} & -\sqrt{u_f}\,\overline{\mathbf{\Omega}\mathbf{\Omega}}^H \sigma_f \\ \overline{\mathbf{o}}^H & \sqrt{u_f} \end{pmatrix} \Theta$,

wherein $\overline{\mathbf{\Omega}}$ is a sub-matrix, $\overline{\mathbf{o}}^H$ is a zero vector, $\overline{\mathbf{\Omega}}^H$ is a complex-conjugate transpose of the sub-matrix, $u_f = \left(\sigma_f - \boldsymbol{\sigma}_f^H \overline{\Omega\Omega}^H \boldsymbol{\sigma}_f\right)$, σ_f is a covariance component, Θ is a series of unitary rotations and H is a complex-conjugate transpose matrix.

18. The equalizer of claim 11, wherein an output signal of an equalizer is generated as $z_k(n) = \beta_k(n)\left(\alpha_k(n)\hat{b}_k(n) + \eta_k^H(n)\mathbf{W}_f^H \tilde{\mathbf{r}}(n)\right)$,

wherein $\alpha_k(n) = \eta_k^H(n)\eta_k(n)$, $\eta_k(n) = \mathbf{W}_f^H \mathbf{h}_k(n)$, $\beta_k(n) = 1 - \dfrac{\alpha_k(n)}{\alpha_k(n) + \left|\hat{b}_k(n)\right|^{-2}}$,

$\mathbf{h}_k(n)$ is a channel response vector, n is an nth symbol, H is a complex-conjugate transpose matrix, $\hat{b}_k(n)$ is a symbol estimate based on a channel decoder feedback, $\mathbf{W}_f = \begin{pmatrix} \overline{\mathbf{\Omega}} & -\sqrt{u_f}\,\overline{\mathbf{\Omega}\mathbf{\Omega}}^H \sigma_f \\ \overline{\mathbf{o}}^H & \sqrt{u_f} \end{pmatrix} \Theta$ wherein $\overline{\mathbf{\Omega}}$ is a sub-matrix, $\overline{\mathbf{o}}^H$ is a zero vector, $\overline{\mathbf{\Omega}}^H$ is a complex-conjugate transpose of the sub-matrix, $u_f = \left(\sigma_f - \boldsymbol{\sigma}_f^H \overline{\Omega\Omega}^H \boldsymbol{\sigma}_f\right)$, σ_f is a covariance component, Θ is a series of unitary rotations and H is a complex-conjugate transpose matrix, $\tilde{\mathbf{r}}(n) = \mathbf{r}(n) - \mathbf{H}\hat{\mathbf{b}}$ where $\mathbf{H}_k(n)$ is a channel response matrix and n means an nth symbol.

19. The equalizer of claim 11, further comprising means for generating the output value of the channel equalizer by further utilizing a-priori symbol estimate information.

20. A receiver comprising:

means for estimating interference from a received signal at a first observation time, creating a first covariance matrix on the basis of the estimation and defining an inverse matrix of the first covariance matrix and a Cholesky decomposition matrix;

means for removing selected covariance components from the Cholesky decomposition matrix;

means for computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix;

means for estimating interference from a received signal at a second observation time and determining additional covariance components on the basis of the estimation;

means for creating the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations; and

means for generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix.

21. An equalizer configured to:

estimate interference from a received signal at a first observation time, creating a first covariance matrix on the basis of the estimation and defining an inverse matrix of the first covariance matrix and a Cholesky decomposition matrix;

remove selected covariance components from the Cholesky decomposition matrix;

compute the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes

covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix;

estimate interference from a received signal at a second observation time and determining additional covariance components on the basis of the estimation;

create the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations; and

generate an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix.

22. A receiver configured to:

estimate interference from a received signal at a first observation time, creating a first covariance matrix on the basis of the estimation and defining an inverse matrix of the first covariance matrix and a Cholesky decomposition matrix;

remove selected covariance components from the Cholesky decomposition matrix;

compute the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix;

estimate interference from a received signal at a second observation time and determining additional covariance components on the basis of the estimation;

create the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations; and

generate an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix.